Australian Government

Geoscience Australia

Session: IGS Workshop Infrastructure Session (PY04)

Improving the efficiency of GNSS data streaming within the IGS

Ryan Ruddick[1], Brandon Owen[1], Jonathan Mettes[1] and Charles Wang[2]

[1] Geoscience Australia

[2] Queensland University of Technology

Geoscience Australia's Data Centre (Statistics)

+ 1000 CORS

+100M
RINEX Files

75 GB per month
Upload

164 GB per month
Download

+500
Streams

+700
Subscribers

2 TB per month
Read

14 TB per month
Written

Optimization of RT infrastructure

- Increasing number of users on primary casters igs-ip.net, mgex.igs-ip.net
- If all registered users would pull the datastreams they are allowed to, the BKG casters would colapse.
- Re-organization of IGS RTS caster network is needed:
  - flat hierarchy in order to keep latency small
  - scalable
  - globally well distributed access points
  - High redundancy
- Encourage station providers to send 2 independent data streams directly to intependent casters
- Encourage station providers to send RTCM-MSM data streams, as soon as possible, preferable in addition to raw data streams (for experimental use only)

Question:

Is there a need to improve how we stream GNSS data and products within the IGS to better support the modern user?

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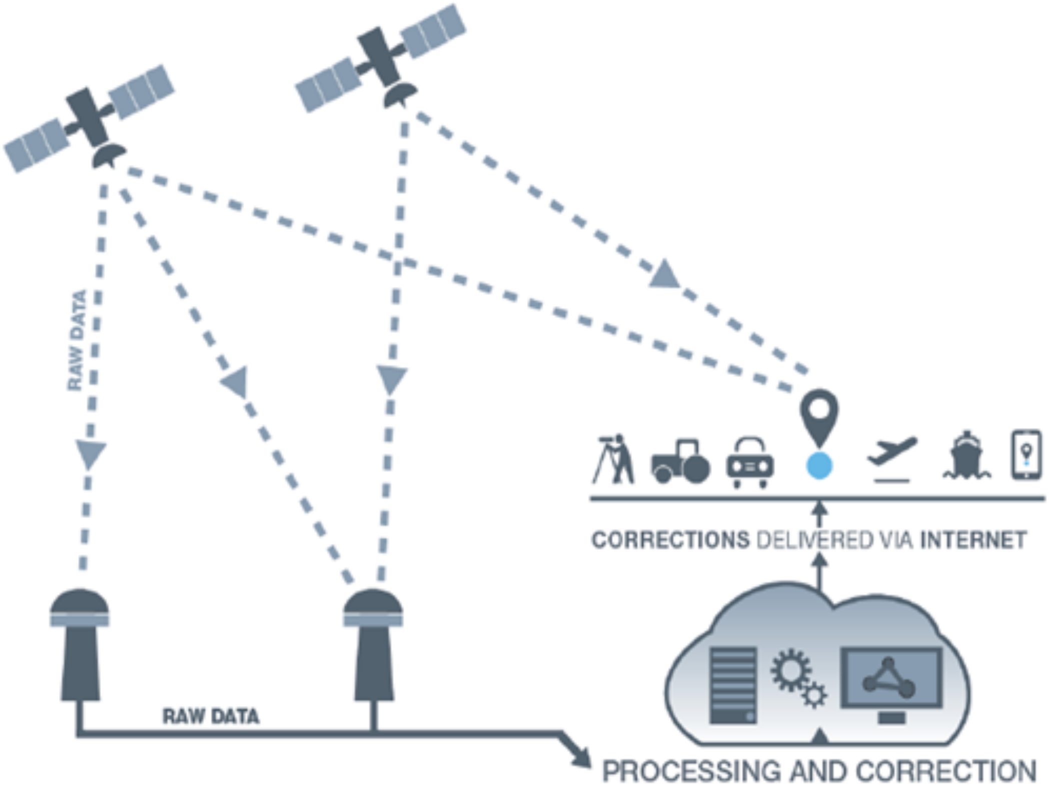
users requiring reliable access in real-time

What is needed:

In an ideal system we would want lower latency, lower bandwidth, guaranteed delivery, less system resources, high reliability, scalability and integrity.



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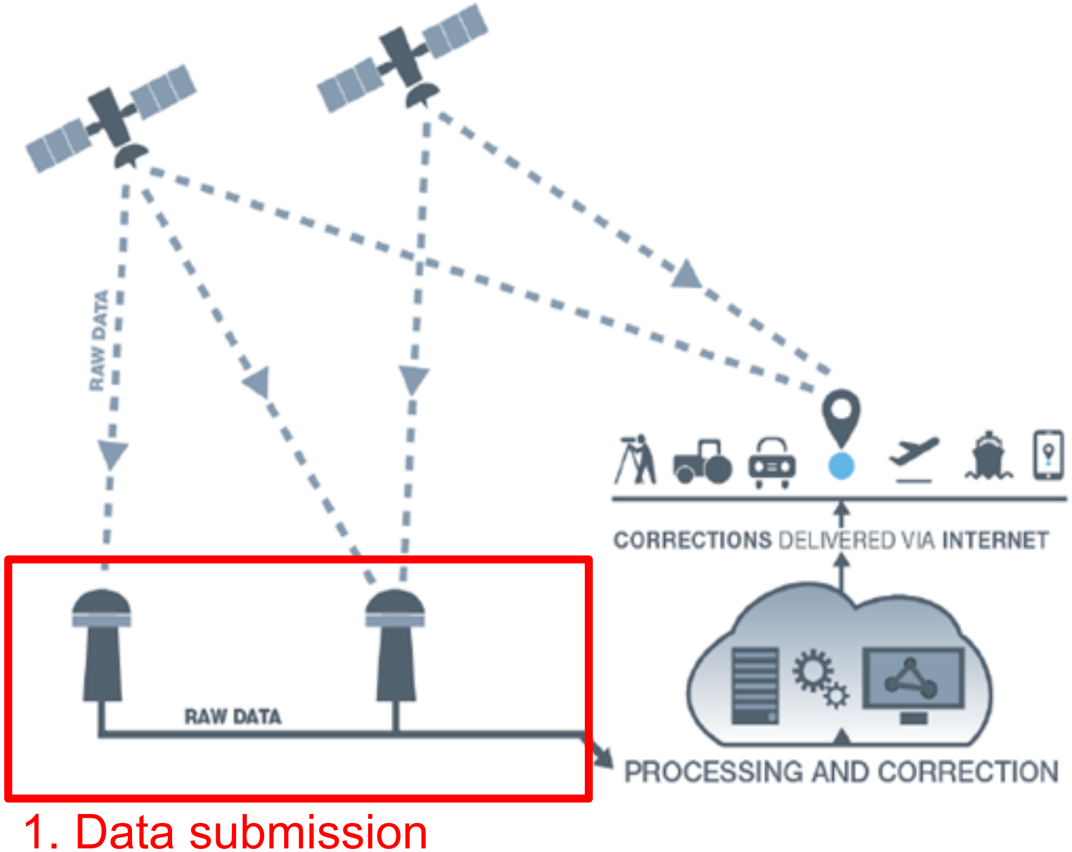

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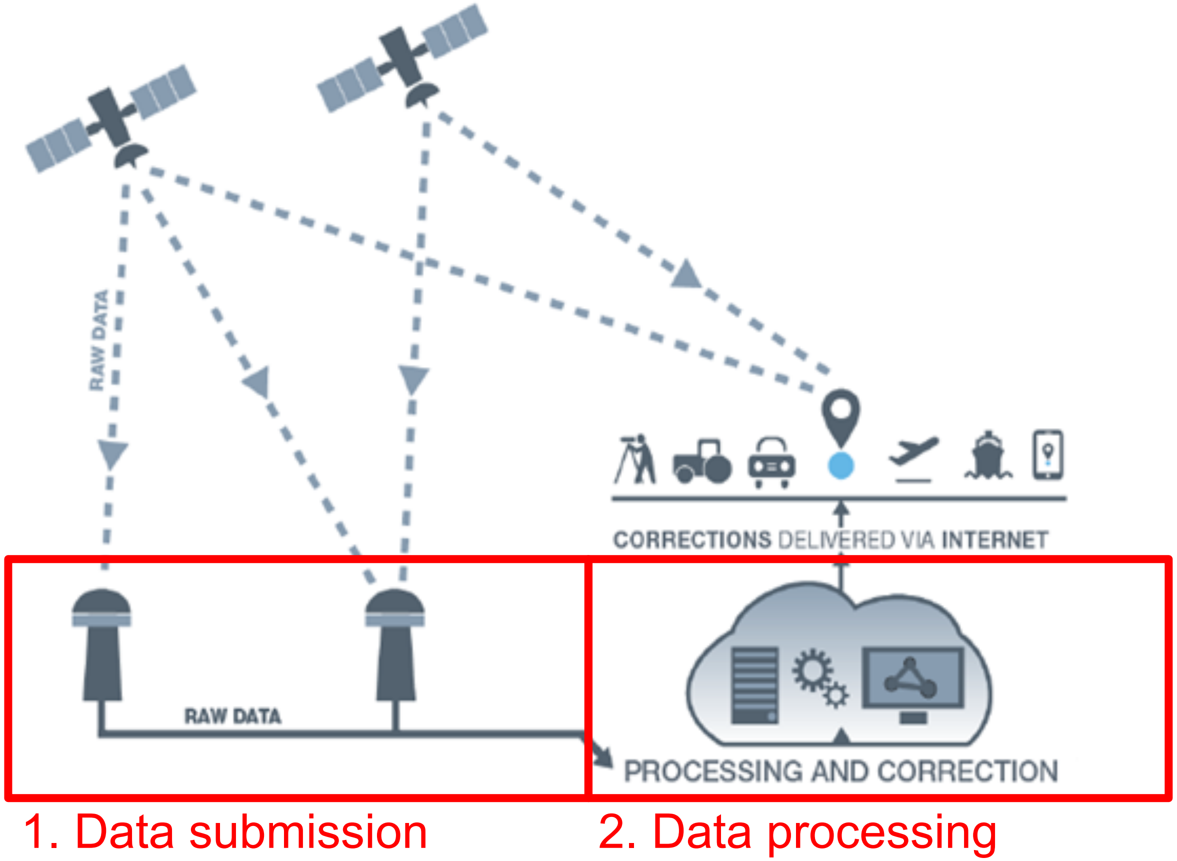

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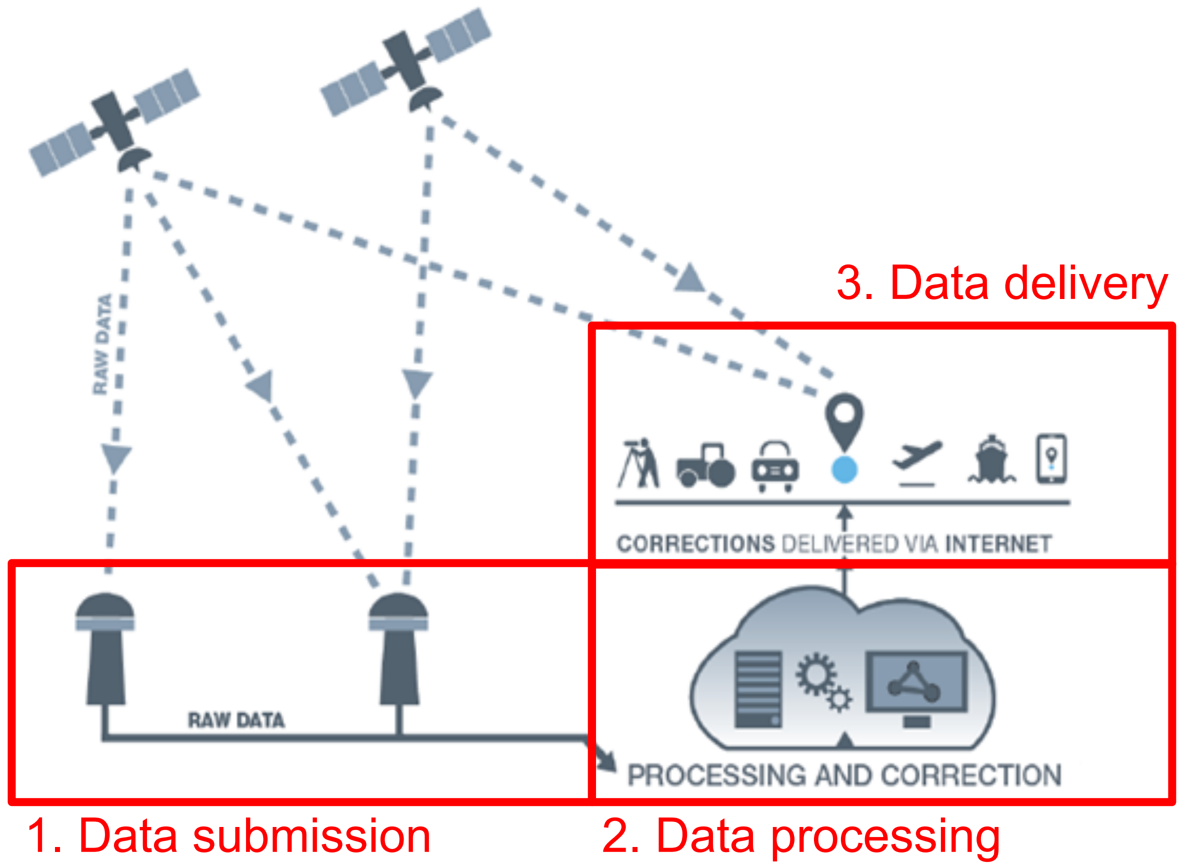

Network Transfer of RTCM over Internet Protocol (NTRIP):

- A stateless protocol for streaming differential GPS/GNSS data over the internet.
- Based on HTTP/1.1 standards.
- Supports 100's of streams and 1000's of clients.

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- Bandwidth intensive (all or nothing).
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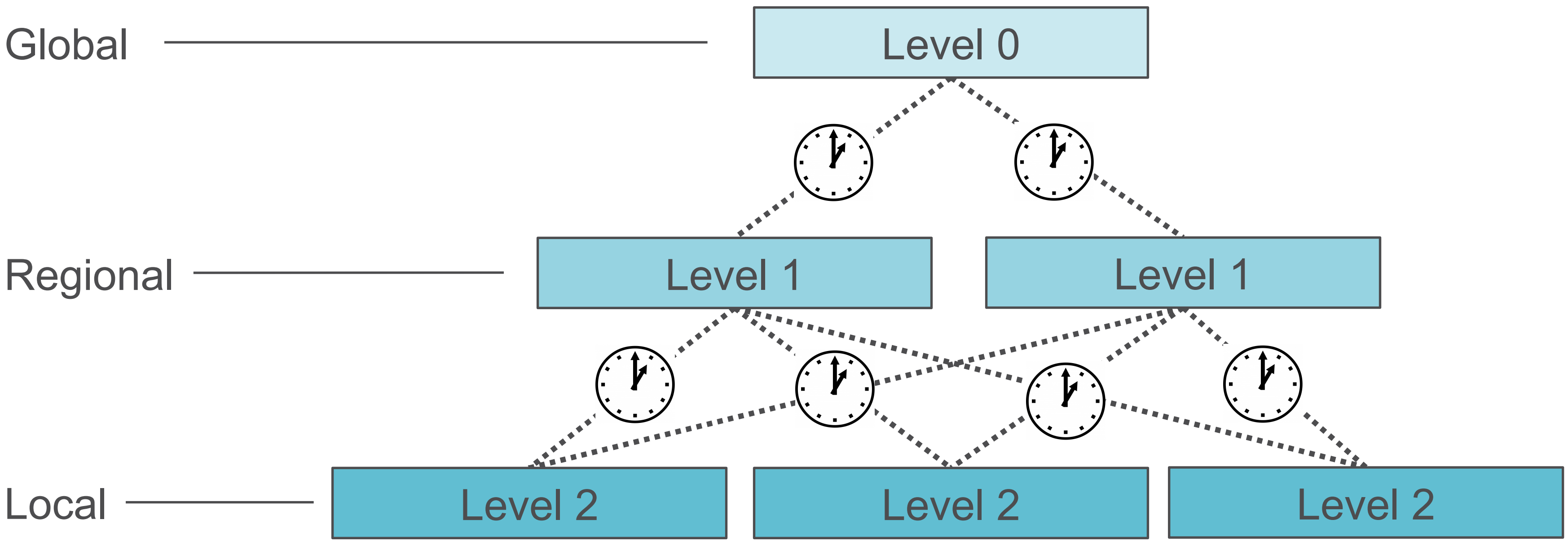
NTRIP Caster Scaling (Vertical)

- Using our current implementation of NTRIP the only way to scale is vertically. This increases both bandwidth and latency.



?

Message Queuing Telemetry Transport Protocol (MQTT):

- An ISO standard (ISO/IEC PRF0922) publish-subscribe based messaging protocol.
- Brokers distribute messages based on a topic.
- Suitable for low bandwidth, low power applications (IoT)
- Used by Facebook, AWS, Microsoft Azure and many more.

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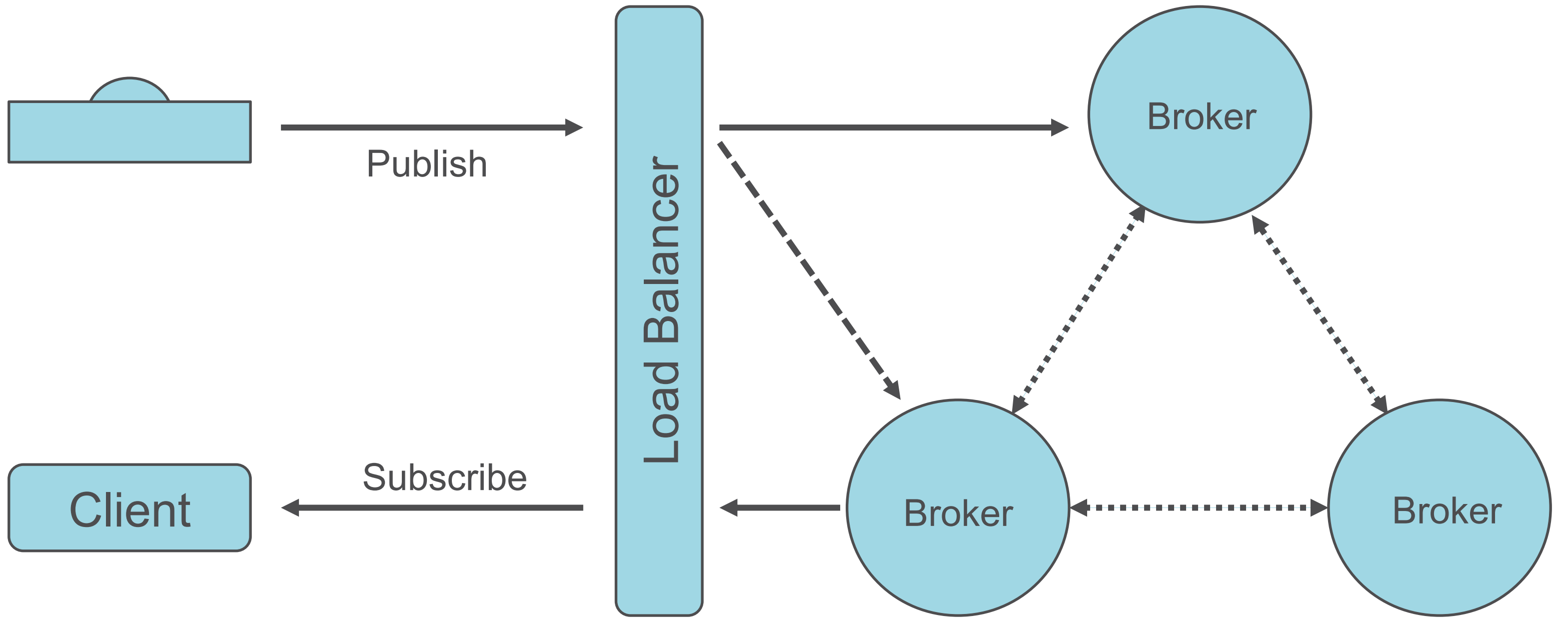
- Scalable through clustering.
- Less system intensive.
- Quality of service and guaranteed delivery.
- Secure connections.
- Data integrity.

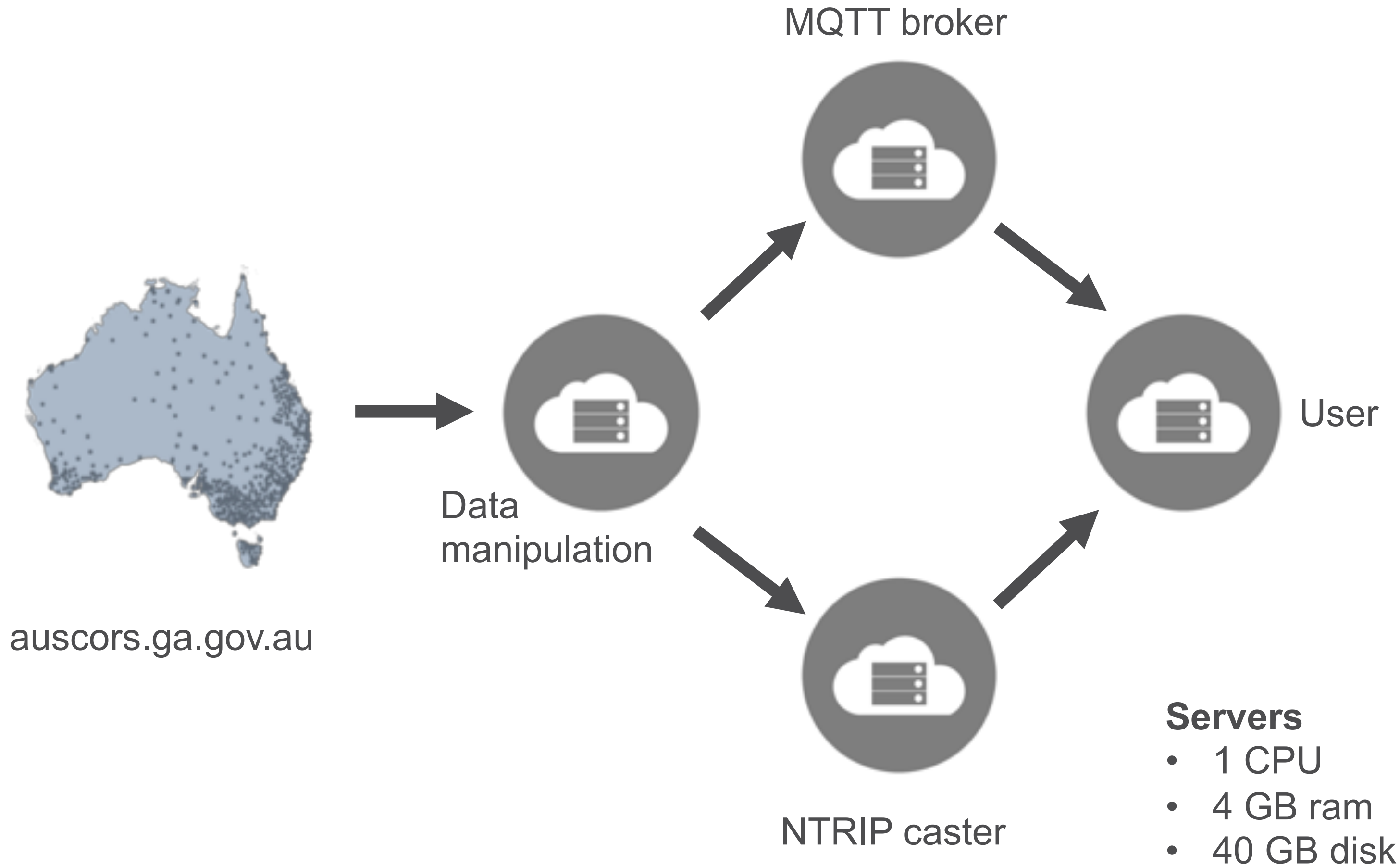
MQTT Broker Scaling (Horizontal or Cluster)

- Using MQTT scaling can be achieved through clustering. This allows for the data to be received with lower latencies and increasing reliability.



Case Study

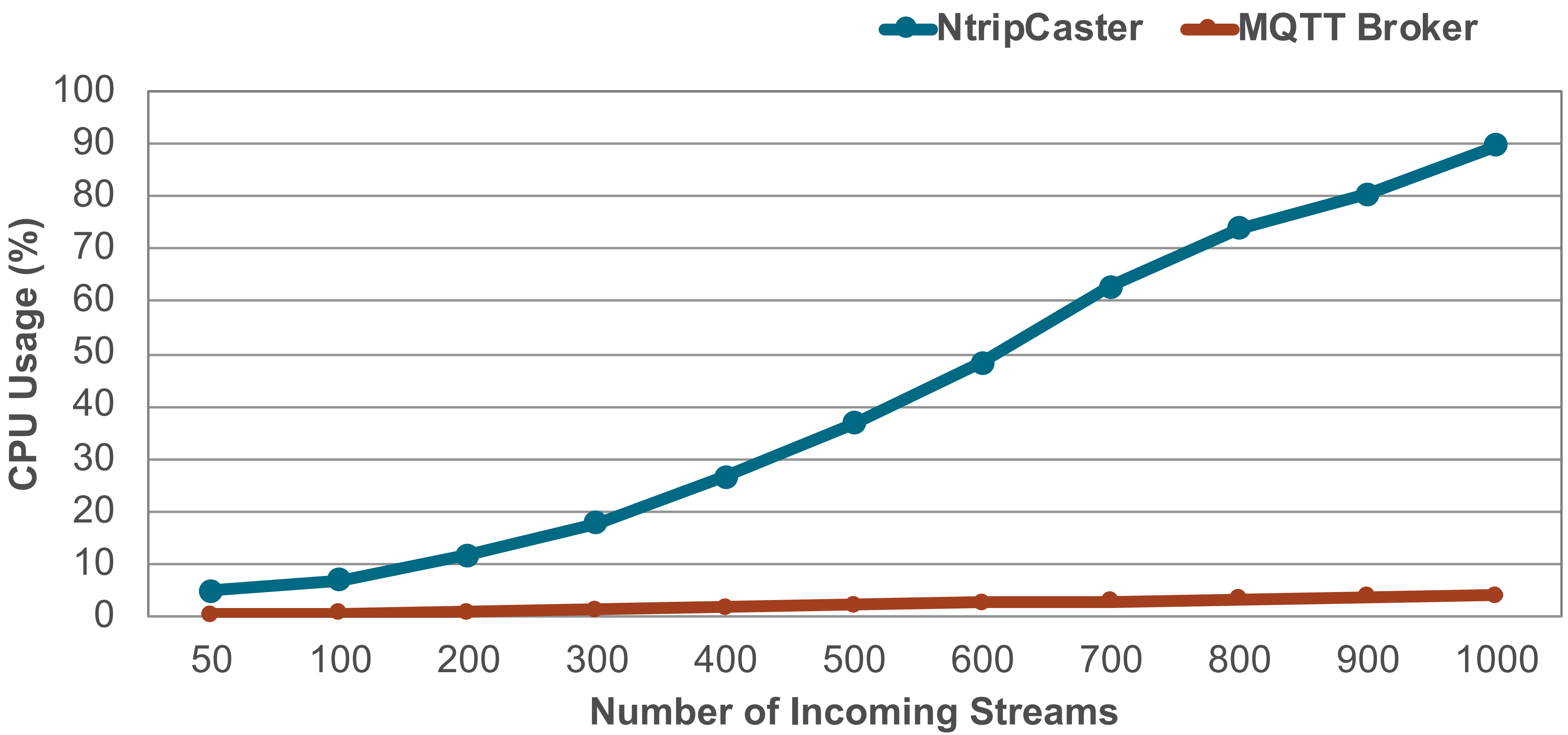
- To compare MQTT and NTRIP a small test bed was established.



Servers
- 1 CPU
- 4 GB ram
- 40 GB disk

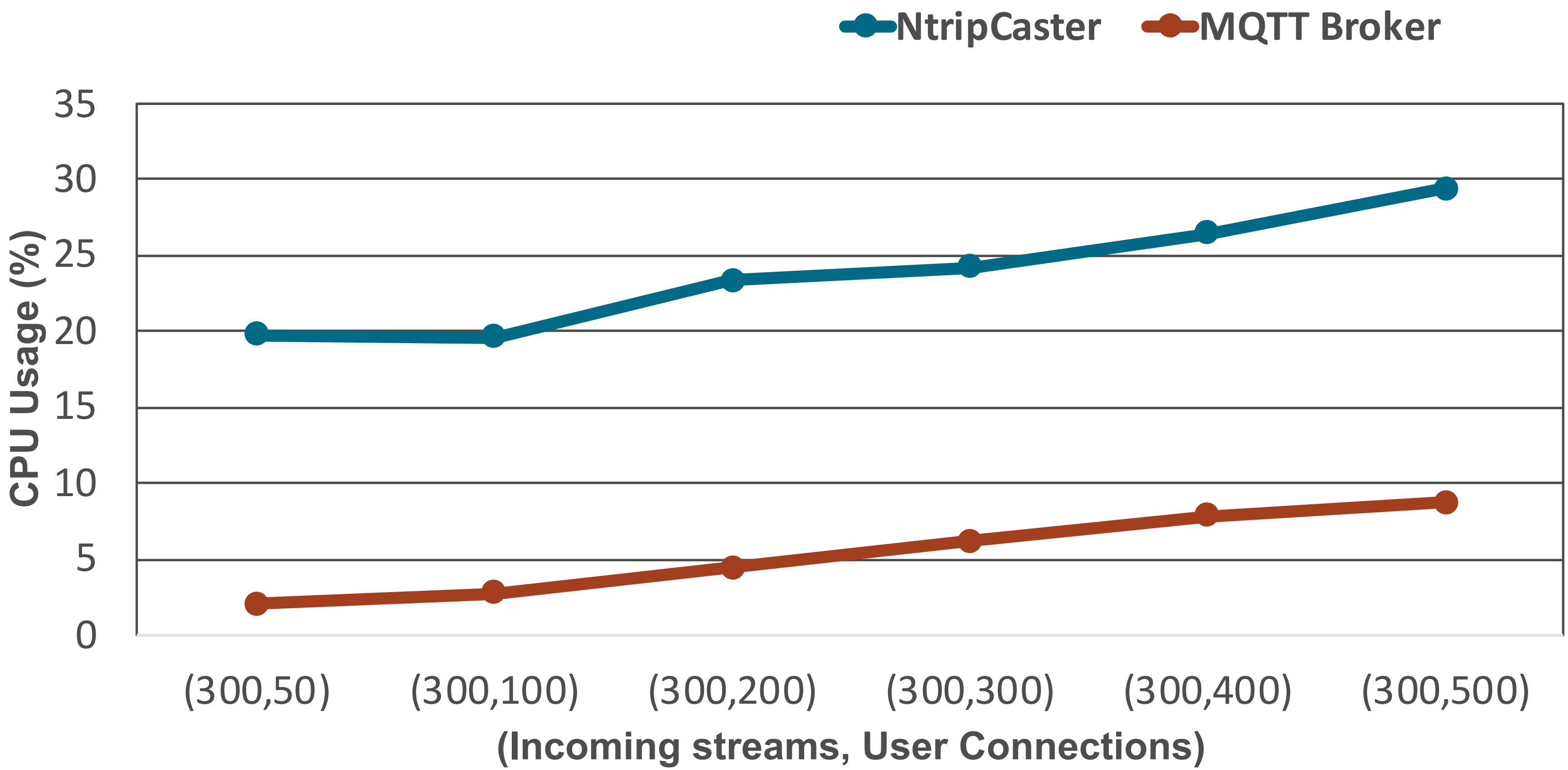
Case Study – System Resources (Incoming Streams)

- MQTT requires less system resources than NTRIP with similar incoming data streams.



Case Study – System Resources (User Connections)

- MQTT puts less strain on system resources as the number of user connections increases.



Case Study – Guaranteed Delivery

Three levels of quality of service (QoS):

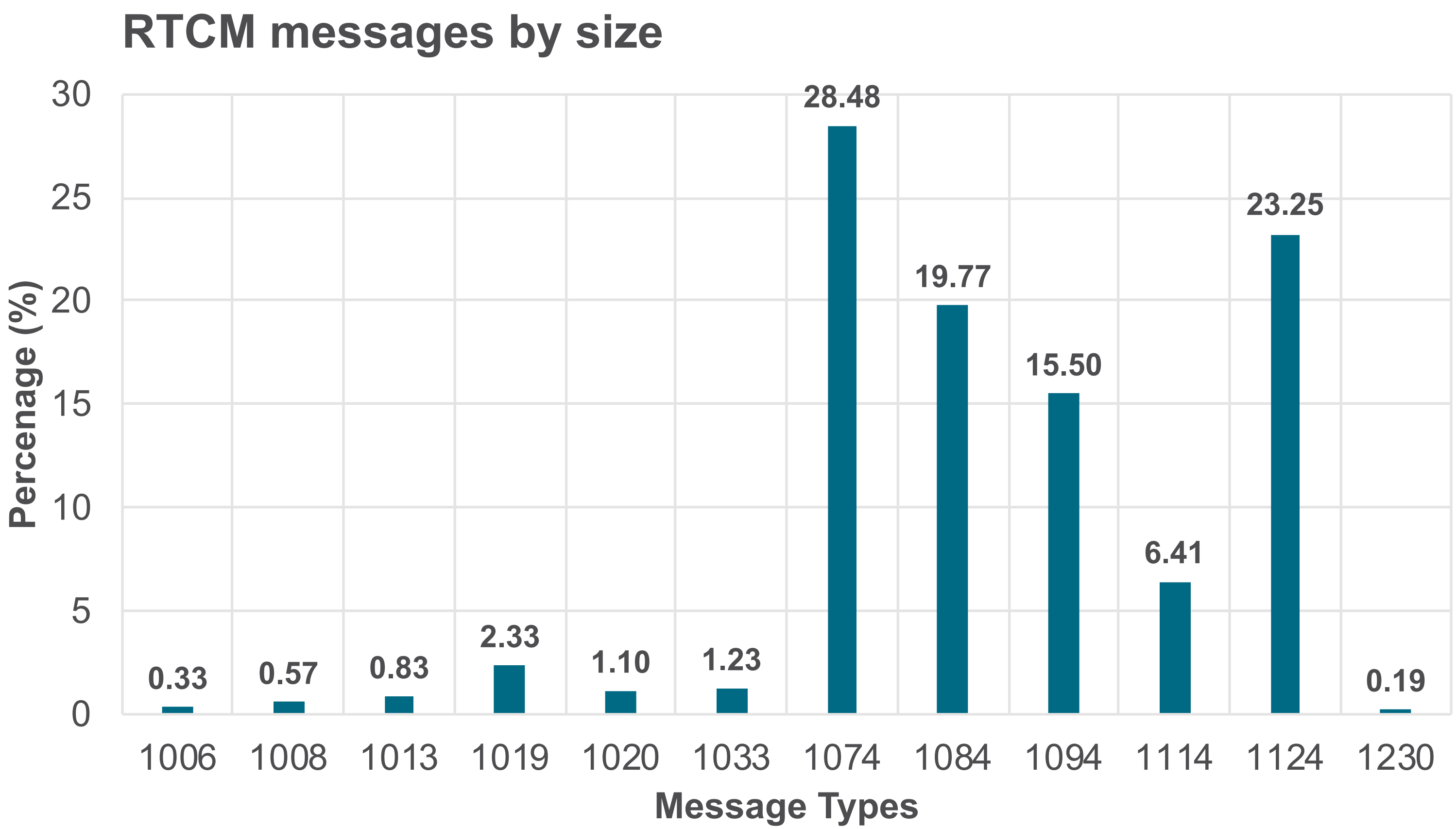
- at most once (level 0)
- at least once (level 1)
- exactly once (level 2)

Persistent session can be used if:

- the client must get all messages from a certain topic,
- the client has limited resources,
- the client needs to publish messages after a reconnect.

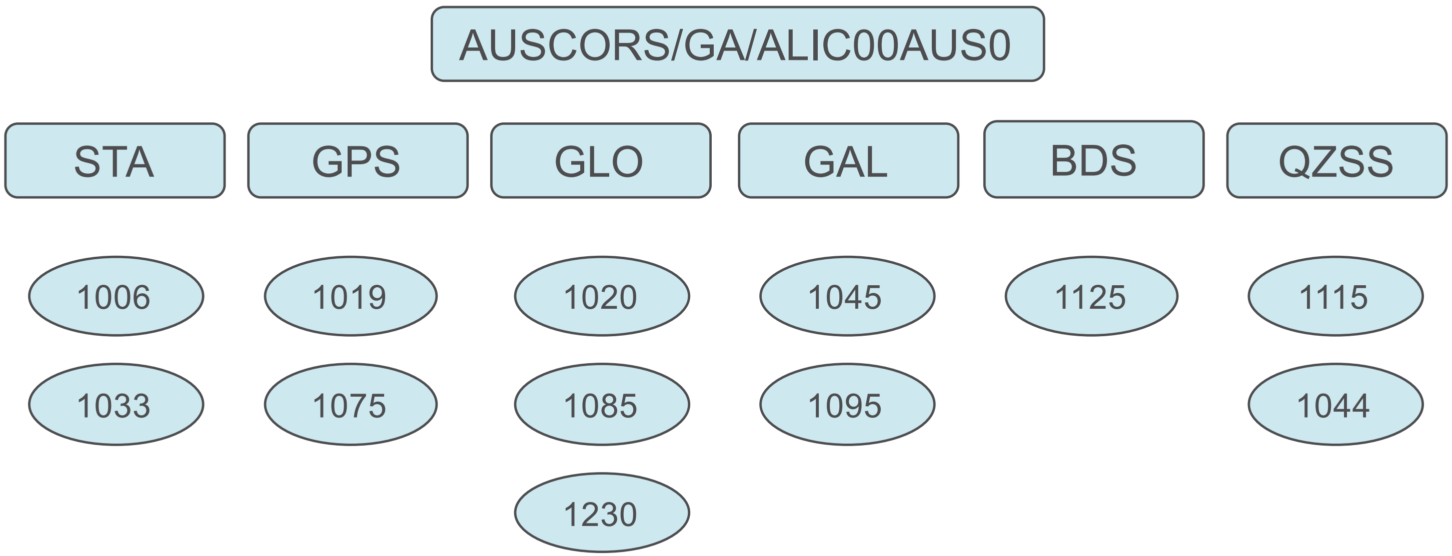
Case Study – Bandwidth (Message Size)

- If a client only needs GPS observations they are wasting ~70% of the stream bandwidth.



Case Study – Bandwidth (Topics)

- MQTT allows users to subscribe to topics. A topic may be a full RTCM message or individual message types.



- Wildcards can be used to get all topics.

AUSCORS/GA/ALIC00AUS0/STA/# *(match all STA messages)*

AUSCORS/GA/ALIC00AUS0/+/OBS *(obs from all constellations)*

Where to from here?

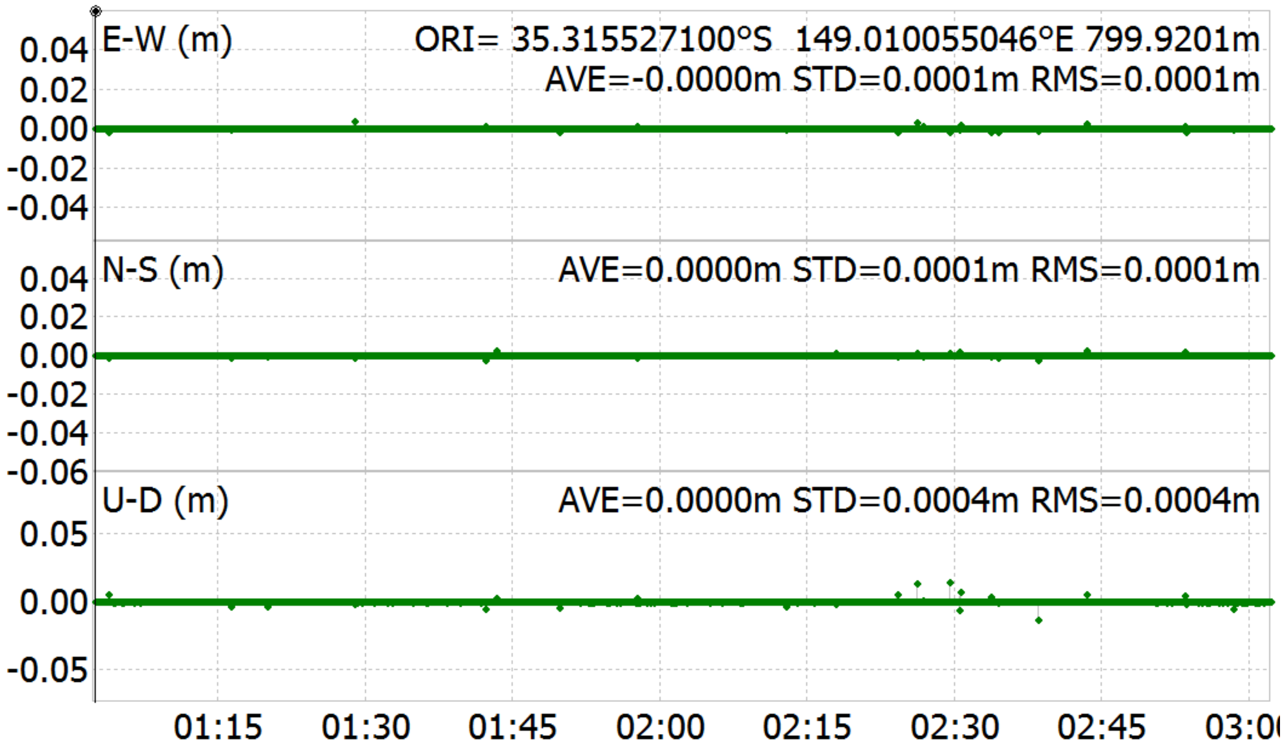
- Present for discussion at IGS workshop.
- Undertake a user requirements study.
- Investigate alternate protocols.
- Further testing.

Benefits to IGS community

- Improved efficiency of GNSS data streaming within the IGS.

Positioning validation

- Insignificant RMS positioning variation between NTRIP/MQTT.
- 0.1 mm horizontal and 0.4 mm vertical.
- Due to latency difference (23 instances, 15 MQTT quicker).



Improving Metadata Transfer

Brown et al (2016), Discovering the Geoscience Australia GNSS Data Repository, IGS Workshop 2016, Sydney.

```
3.7  Receiver Type            : LEICA GRX1200GGPRO
     Satellite System         : GPS+GLO
     Serial Number            : 355318
     Firmware Version         : 6.00
     Elevation Cutoff Setting : 0 deg
     Date Installed           : 2008-09-17T00:00Z
     Date Removed             : 2009-07-24T00:00Z
     Temperature Stabiliz.    : none
     Additional Information   :
```


```
<geo:gnssReceiver gml:id="GNSS_REC_7">
        <geo:manufacturerSerialNumber>ZR520021114</geo:manufacturerSerialNumber>
        <geo:receiverType codeSpace="urn:igs-org:gnss-receiver-model-code" codeList="http://xml.
        <geo:satelliteSystem>GPS</geo:satelliteSystem>
        <geo:serialNumber>ZR520021114</geo:serialNumber>
        <geo:firmwareVersion>ZC00</geo:firmwareVersion>
        <geo:elevationCutoffSetting>0</geo:elevationCutoffSetting>
        <geo:dateInstalled>2002-10-29T00:00:00Z</geo:dateInstalled>
        <geo:dateRemoved>2006-01-23T23:59:00Z</geo:dateRemoved>
        <geo:temperatureStabilization>none</geo:temperatureStabilization>
        <geo:notes/>
</geo:gnssReceiver>
```

Improving RINEX File Transfer

Zhou et al (2018), Discovering the Geoscience Australia GNSS Data Repository, IGS Workshop 2018, Wuhan.

Index of /geodesy-outgoing/gnss/data/daily/2018/18001/

[parent directory]

Name	Size	Date Modified
00na0010.18d.Z	1.3 MB	02/01/2018, 11:00:00
00na0010.18g.Z	36.5 kB	02/01/2018, 11:00:00
00na0010.18n.Z	34.8 kB	02/01/2018, 11:00:00
01na0010.18d.Z	1.3 MB	02/01/2018, 11:00:00
01na0010.18g.Z	36.5 kB	02/01/2018, 11:00:00
01na0010.18n.Z	34.5 kB	02/01/2018, 11:00:00
abny0010.18d.Z	569 kB	16/01/2018, 11:00:00
alby0010.18d.Z	1.0 MB	02/01/2018, 11:00:00
alby0010.18g.Z	39.3 kB	02/01/2018, 11:00:00
alby0010.18m.Z	24.4 kB	02/01/2018, 11:00:00
alby0010.18n.Z	39.9 kB	02/01/2018, 11:00:00
ALBY00AUS_R_20180010000_01D_30S_MM.rnx.gz	12.6 kB	02/01/2018, 11:00:00
ALBY00AUS_R_20180010000_01D_30S_MO.crx.gz	4.3 MB	02/01/2018, 11:00:00
ALBY00AUS_R_20180010000_01D_MN.rnx.gz	202 kB	02/01/2018, 11:00:00
alic0010.18d.Z	676 kB	02/01/2018, 11:00:00
alic0010.18g.Z	36.3 kB	02/01/2018, 11:00:00
alic0010.18m.Z	25.8 kB	02/01/2018, 11:00:00
alic0010.18n.Z	37.3 kB	02/01/2018, 11:00:00
ALIC00AUS_R_20180010000_01D_30S_MM.rnx.gz	12.1 kB	02/01/2018, 11:00:00
ALIC00AUS_R_20180010000_01D_30S_MO.crx.gz	2.1 MB	02/01/2018, 11:00:00
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